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Gilmore

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(54) **LINE STRUCTURE FOR MARINE USE IN CONTAMINATED ENVIRONMENTS**

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(51) **Int. Cl.**
D02G 3/02 (2006.01)
D02G 3/22 (2006.01)

(52) **U.S. Cl.** **57/211**

(58) **Field of Classification Search** 57/210–235
See application file for complete search history.

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(57) **ABSTRACT**

The present invention may be embodied as a line structure for use as a mud line assembly. In this case, the line structure comprises a plurality of strands, and each of the strands comprises a core portion, a jacket portion, and a barrier portion. The barrier portion is arranged between the core portion and the jacket portion to inhibit movement of contaminate material into the core portion.

19 Claims, 2 Drawing Sheets

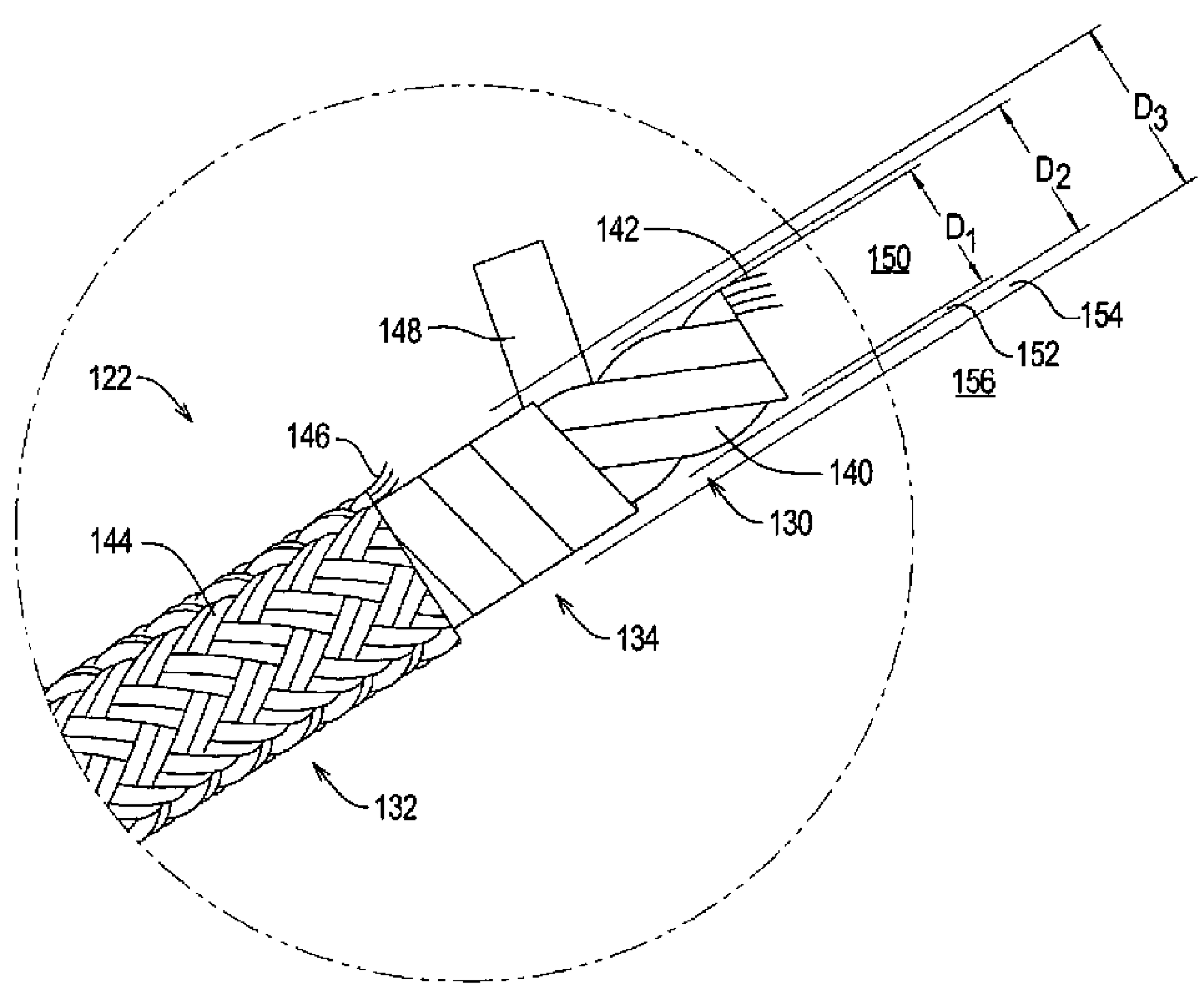

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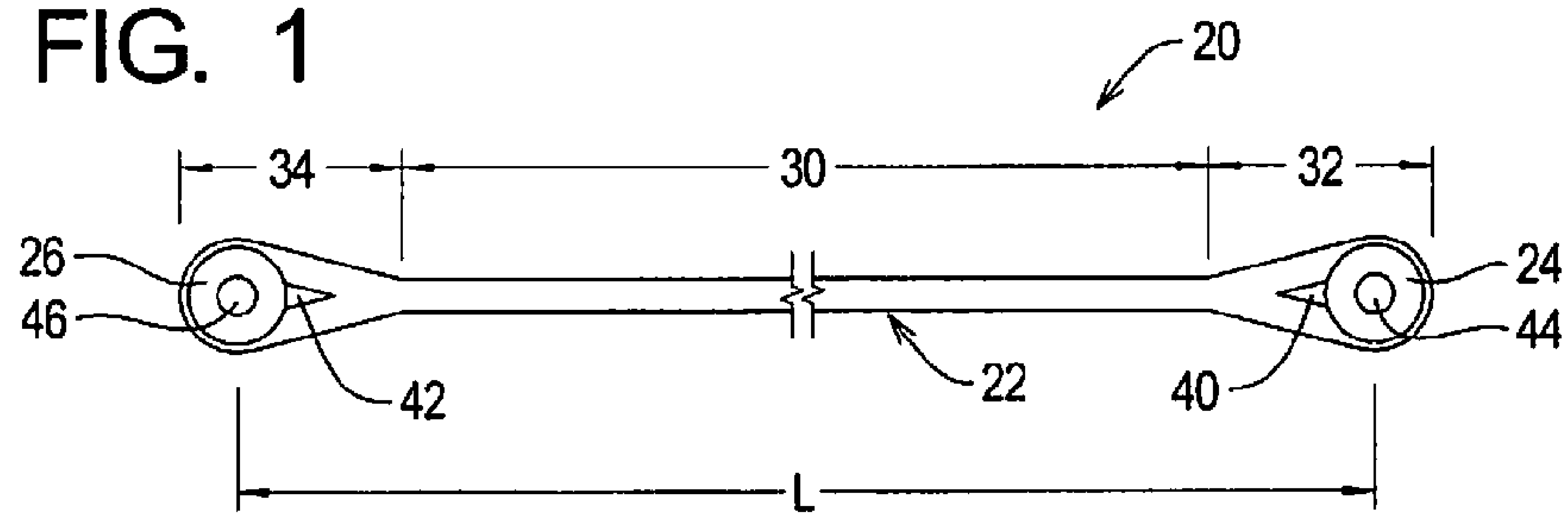
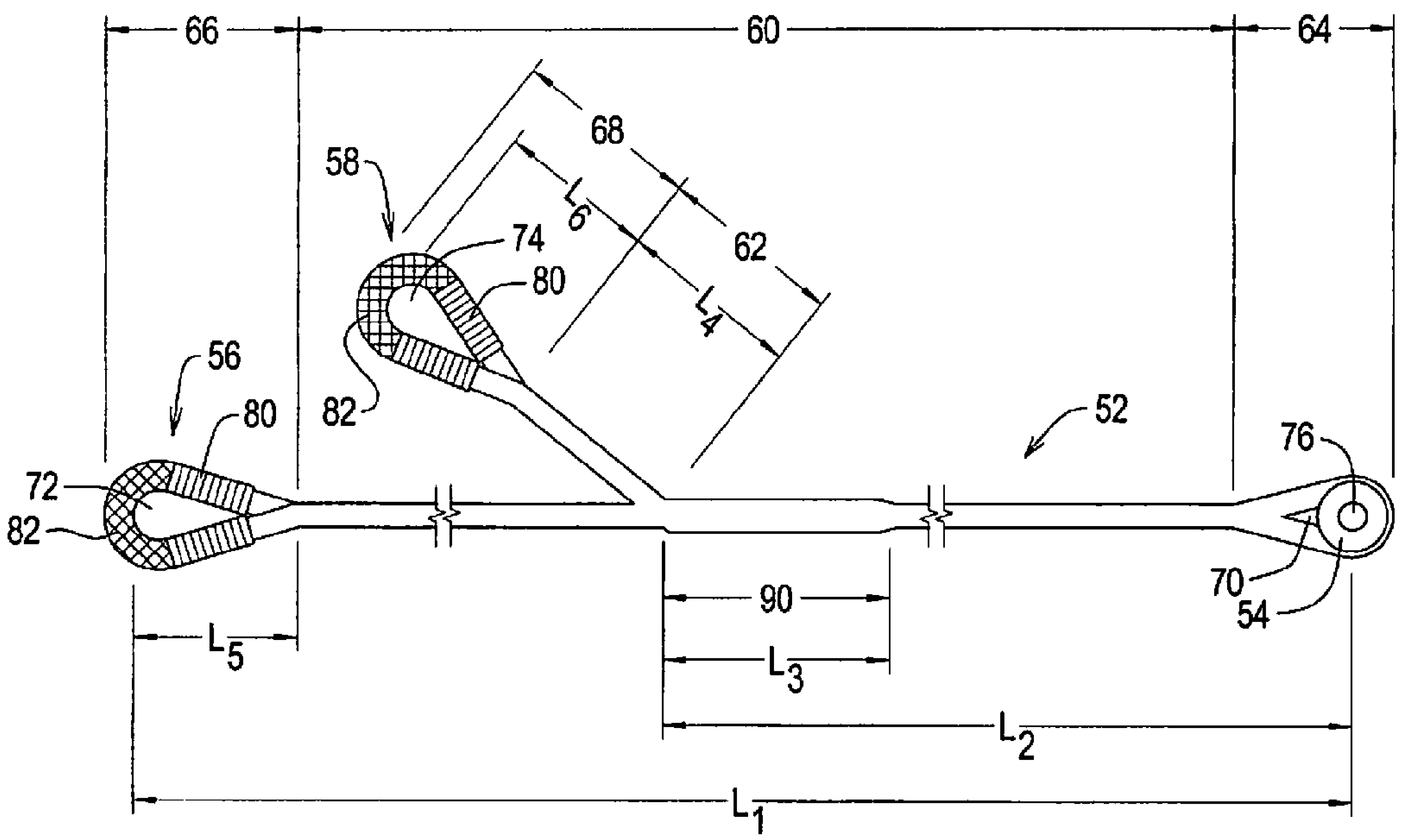
FIG. 1



20
34
30
32
26
46
42
22
40
24
44
L

FIG. 2



66
60
64
68
58
74
80
82
62
L_6
L_4
56
80
52
76
72
82
70
54
90
L_5
L_3
L_2
L_1

FIG. 3

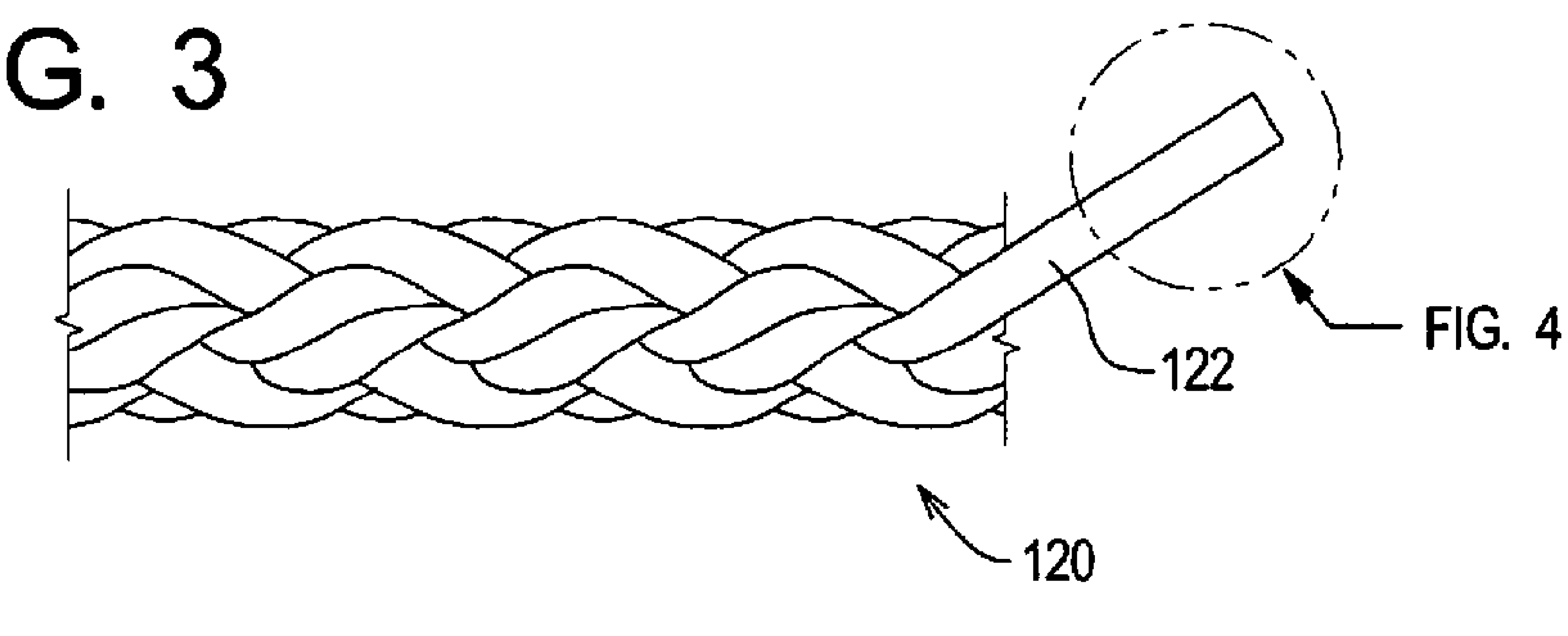
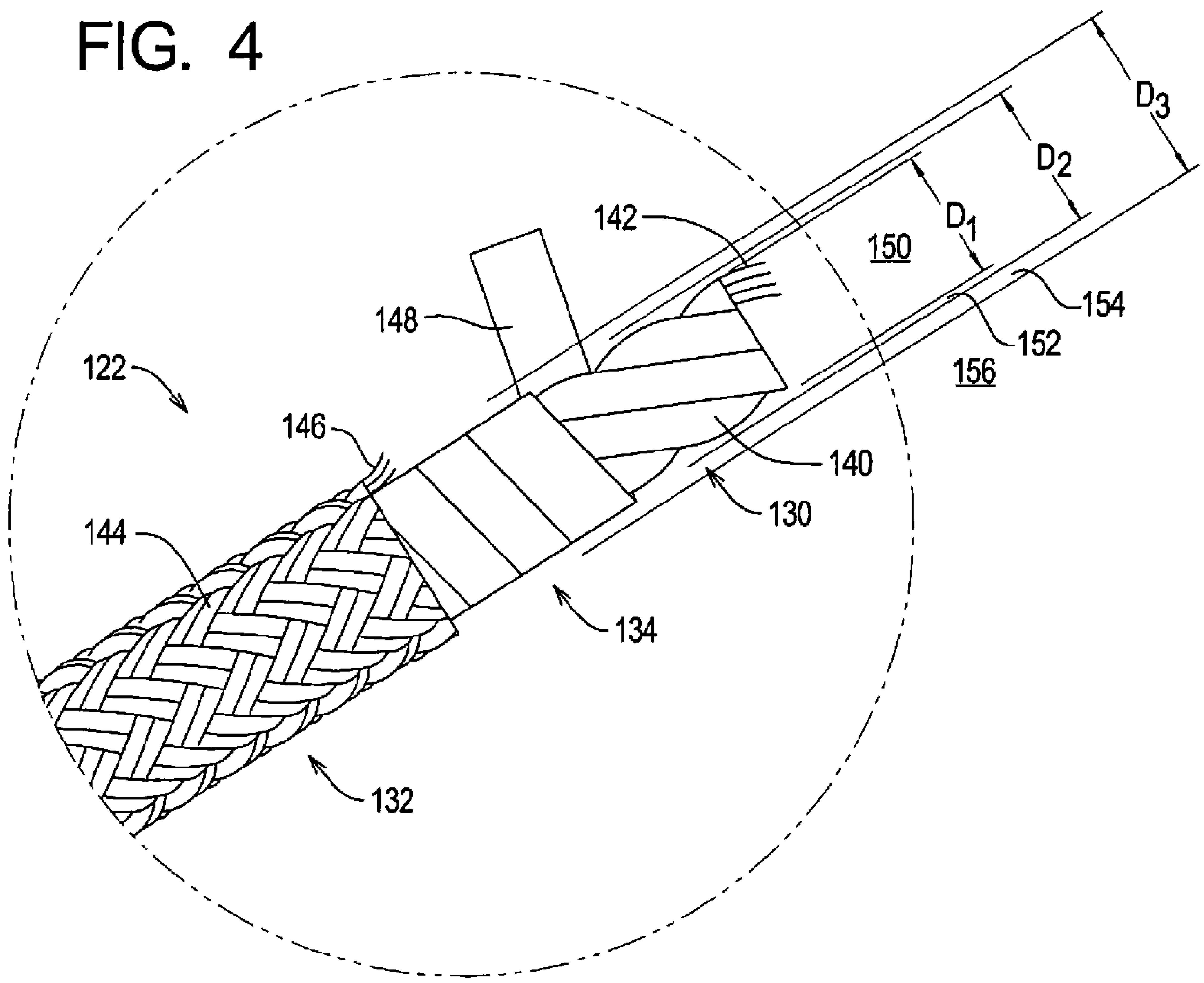

122
FIG. 4
120

FIG. 4


D3
D2
D1
142
150
148
154
152
156
122
146
140
130
144
134
132

LINE STRUCTURE FOR MARINE USE IN CONTAMINATED ENVIRONMENTS

RELATED APPLICATIONS

This application claims priority of U.S. Provisional Patent Application Ser. No. 61/127,881 filed May 16, 2008, the contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to lines for use in marine environments and, more particularly, to lines designed for use in applications where at least a portion of the line is in a contaminated environment such as on or below the surface of the sea floor.

BACKGROUND

The term "mud line" is conventionally used in the petroleum industry to refer to the boundary between earth and water. An anchor assembly used as part of an offshore anchoring system is typically submerged in the silt and mud defining the mud line at the bottom of the body of water. Conventional anchor assemblies typically employ chains, wires, or cables made of metal. The need exists for improved anchor assemblies and line structures for use as part of anchor assemblies.

SUMMARY

The present invention may be embodied as a line assembly comprising a line structure comprising a plurality of strands, where each of the strands comprises a core portion, a jacket portion, and a barrier portion. The barrier portion is arranged between the core portion and the jacket portion to inhibit movement of contaminate material into the core portion.

The present invention may also be embodied as a line structure for use as a mud line assembly. In this case, the line structure comprises a plurality of strands, and each of the strands comprises a core portion, a jacket portion, and a barrier portion. The barrier portion is arranged between the core portion and the jacket portion to inhibit movement of contaminate material into the core portion.

The present invention may also be embodied as a line assembly comprising a line structure comprising a plurality of strands, where each of the strands comprises a core portion, a jacket portion, and a barrier portion comprising filter material. The filter material is arranged around the core portion to inhibit movement of contaminate material into the core portion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a first example line assembly constructed in accordance with, and embodying, the principles of the present invention;

FIG. **2** is a perspective view of a second example line assembly constructed in accordance with, and embodying, the principles of the present invention;

FIG. **3** is a view of a section of the first and second example line assemblies depicted in FIGS. **1** and **2**; and

FIG. **4** is a view of a section of an example strand that may be used as part of the first and second example line assemblies depicted in FIGS. **1** and **2**.

DETAILED DESCRIPTION

Referring initially to FIG. **1** of the drawing, depicted therein is a first example line assembly **20** of the present

invention comprising a line member **22** and optional first and second thimbles **24** and **26**. The line member **22** defines an intermediate portion **30** and first and second end portions **32** and **34**. The first and second end portions **32** and **34** define first and second end openings **40** and **42**, respectively. The end portions **32** and **34** are or may be formed by conventional techniques for terminating line structures.

If used, the thimbles **24** and **26** are arranged within the end openings **40** and **42**, respectively, in a conventional manner. The thimbles **24** and **26** are or may be conventional and define generally circular thimble openings **44** and **46**, respectively. The thimbles **24** and **26** are designed to protect the line member **22** while transferring to the line member **22** loads from other components (not shown) of the anchoring system in which the line assembly **20** is used.

The first example line assembly **20** defines a length L between the centers of the thimble openings **44** and **46**. The length L of the example line assembly **20** is approximately 335 feet; however the length of any line assembly constructed in accordance with the principles of the present invention will be determined based on the particular operating conditions under which the line assembly is to be used.

Turning now to FIG. **2** of the drawing, depicted therein is a second example line assembly **50** comprises a line member **52**, an optional thimble **54**, and optional first and second protection assemblies **56** and **58**. The line member **52** defines an intermediate portion **60**, a deployment portion **62**, and first, second and third end portions **64**, **66**, and **68**. The first, second, and third end portions **64**, **66**, and **68** define first, second, and third end openings **70**, **72**, and **74**, respectively. The end portions **64**, **66**, and **68** are or may be formed by conventional techniques for terminating line structures.

The thimble **54** is arranged within the first end opening **70** in a conventional manner. The thimble **54** is or may be conventional and defines a generally circular thimble opening **76**. The thimble opening **76** is designed to transfer to the line member **52** loads from other components (not shown) of the anchoring system in which the line assembly **50** is used.

The protection structures **56** and **58** are arranged to cover portions of the second and third end portions **66** and **68** of the line member **52** defining the second and third end openings **72** and **74**, respectively. The example protection structures **56** and **58** each comprise a whipping structure **80** and a chafe structure **82**. The whipping structure **80** is first wrapped around portions of the second and third end portions **66** and **68** of the line member **52**. The chafe structure **82** is then wrapped around at least a portion of the whipping structure **80**. The protection structures **56** and **58** are or may be formed in a conventional manner and are designed to protect the line member **52** when the line assembly **50** is connected to other components (not shown) of the anchoring system in which the line assembly **50** is used.

The second example line assembly **50** defines a primary length L_1 between the center of the thimble opening **76** and the inside surface of the second end portion **66** defining the second end opening **72**. The second example line assembly **50** further defines a secondary length L_2 between the center of the thimble opening **76** and the point at which the deployment portion **62** extends from the intermediate portion **60**. The example deployment portion **62** is spliced into the intermediate portion **60** over a splice area **90** having a splice length L_3. The deployment portion **62** defines a deployment length L_4. The second and third end portions **66** and **68** define first and second end lengths L_5 and L_6, respectively.

In the example line assembly **50**, the primary length L_1 is approximately 105 feet, the secondary length L_2 is approximately 37 feet, the splice length L_3 is approximately 12 feet, the deployment length L_4 is approximately 10 feet, and the first and second end lengths L_5 and L_6, are approximately 8 feet. Again, the lengths of any line assembly constructed in accordance with the principles of the present invention will be determined based on the particular operating conditions under which the line assembly is to be used.

The line members **22** and **52** may differ in construction, composition, geometry, and dimensions, but share certain characteristics that render these members **22** and **52** appropriate for use as part of the line assemblies **20** and **50** described above. In addition, the characteristics shared by the line members **22** and **52** may be configured for use as part of any line system or assembly that will be subjected to operating conditions similar to those encountered by the example line assemblies **20** and **50** described herein. In the following discussion, an example line structure that may be used to form the line members **22** and **52** will be described in further detail.

Referring now to FIGS. **3** and **4** of the drawing, depicted therein is an example line structure **120** that may be used to form the example line members **22** and **52** or any other line member designed for use under similar operating conditions. The example line structure **120** comprises a plurality of strands **122** as shown in FIG. **3**. The strands **122** are combined in any conventional manner to obtain a line structure **120** that meets the load conditions of the intended use environment.

The strands **122** in turn comprise a core portion **130**, a jacket portion **132**, and a barrier portion **134**. The core portion **130** comprises a plurality of core yarns **140** comprising core fibers **142**, while the jacket portion **132** comprises a plurality of jacket yarns **144** comprising a plurality of jacket fibers **146**. The core yarns **140** and jacket yarns **144** in turn may comprise a plurality of components such as smaller yarns or bundles of fibers. The barrier portion **134** comprises at least one strip of barrier material **148** that is arranged between the core portion **130** and the jacket portion **132**.

The example strands **122** thus define an interior region **150** that is substantially but not completely occupied by the core fibers **142** forming the core portion **130**. In cross-section, the interior region **150** is substantially in the shape of a circle having a core diameter D_1. The example strands **122** further define a barrier region **152** that is substantially occupied by the barrier material **148**. In cross-section, the barrier region is substantially annular, with an inner diameter of equal to the core diameter D_1 and an outer diameter equal to a barrier diameter D_2. The example strands **122** further define a jacket region **154** that is substantially occupied by the jacket fibers **146** defining the jacket portion **132**. In cross-section, the jacket region **154** is substantially annular, with an inner diameter of equal to the barrier diameter D_2 and an outer diameter equal to a jacket diameter D_3. The jacket diameter D_3 defines the nominal diameter of the example strands **122**. An exterior region **156** is defined as anything outside of the outer boundaries of the barrier region **152**.

The barrier material **148** is arranged to inhibit movement of contaminate material from the exterior region **156** to the interior region **150**. Contaminate material is any foreign matter not present in the line structure **120** when originally manufactured. In general, contaminate material enters line structures over time. When mixed in with the fibers forming a line structure, contaminate material can be detrimental to the operation and/or wear life of the line structure.

In the context of a line structure intended for use as an anchor assembly or under similar conditions, the line structure is often submerged under pressure in a liquid bath of fine particles suspended within water. The applicant has determined that, under pressure and movement of the line structure, the suspended particles easily flow within the rope structure. The Applicant has further determined that problems associated with the intrusion of contaminate material are exacerbated in the context of a line structure designed for use as part of an anchor assembly or the like because contaminate material between and around the fibers forming the line structure degrades the line structure and can cause failure thereof.

In the context of the example line structure **120**, the core portion **130** forms the prime load bearing element of the line structure **120**. The barrier material **148** is arranged to inhibit contamination of the core portion **130** by contaminate material, even though the entire line structure **120** may be submerged within a fluid bath comprising particulates. The barrier material **148** thus improves abrasion resistance of the overall line structure **120**. The operation and/or wear life of the core fibers **142** is thus less likely to be adversely affected by contaminate material.

The example barrier material **148** is designed to prevent egression of particulate material down to 2 microns in size (i.e., greater than approximately 2 microns). The exact specifications of the barrier material **148** can be selected based on the particular environment in which the line structure **120** is to be used.

The example barrier material **148** is a strip of filter tape that is wrapped in a helical configuration around the core portion **130** with edges of the filter tape overlapping as perhaps best shown at **160** in FIG. **4**. Accordingly, when wrapped around the entire core portion **130**, the filter tape forming the barrier material **148** forms a continuous barrier in the barrier region **152** that inhibits the egression of particulate from the exterior region **156** to the interior region **150**.

The filter tape forming the barrier material **148** may comprise adhesive material on one side such that the barrier material **148** adheres to itself and to the core portion **130**. If used, the adhesive material helps the barrier material to stay in place around the core portion **130**.

In the example line structure **120**, the jacket portion **132** is formed by a tight cover braid of urethane coated jacket fibers **146**. The jacket portion **132** surrounds the barrier material **148**, protecting the barrier material **148** and holding the barrier material **148** in place around the core portion **130**. The jacket portion **132** further provides stiffness to the line structure **120**. Providing stiffness to the line structure **120** aids with ROV connections commonly used when installing, servicing, and removing offshore anchoring systems.

The example strands **122** employ an 8×3 construction. Although other constructions may be possible, the 8×3 construction provides the advantages of both laid and braided ropes.

The core fibers **142** and the jacket fibers **146** of the example line structure **120** employs are formed by high molecular polyethylene (HMPE). HMPE fibers provide good strength and abrasion resistance. HMPE also provides a low specific gravity, meaning that the line structure **120** will float in water. Using a line structure **120** capable of floating in water yields a line member that simplifies the connection of mooring lines and anchor retrieval. Other fibers such as LCPs are also candidates for use in line structures configured for use as anchor line assemblies and the like.

The present invention is of particular significance when used as part of the Delmar Systems Inc. Omni-Max anchoring system, and the two example line assemblies **22** and **52** disclosed herein are configured for use as part of the Omni-Max anchoring system. However, the concepts of the present invention may be applied to any line member intended for use under similar operating conditions.

What is claimed is:

1. A line assembly adapted for underwater use at the boundary between earth and water, comprising:
   - a line structure comprising a plurality of strands, where each of the strands comprises
     - a core portion comprising a plurality of core yarns, where each of the core yarns comprises a plurality of core fibers,
     - a jacket portion comprising a plurality of jacket yarns, where each of the jacket yarns comprises a plurality of jacket fibers, and
     - a barrier portion provided for each strand; wherein
   - the barrier portion is arranged between the core portion and the jacket portion of each strand to inhibit movement of contaminate material into the core portions of the strands.

2. A line assembly as recited in claim **1**, in which the barrier portion comprises filter material arranged around each core portion.

3. A line assembly as recited in claim **1**, in which the barrier portion comprises at least one strip of filter material arranged around each core portion.

4. A line assembly as recited in claim **1**, in which the barrier portion comprises at least one strip of filter tape arranged around each core portion.

5. A line assembly as recited in claim **4**, in which the filter tape defines at least one adhesive surface adapted to secure the filter tape to each core portion.

6. A line assembly as recited in claim **4**, in which the filter tape is wrapped around each core portion in a helical configuration.

7. A line assembly as recited in claim **6**, in which edges of the filter tape overlap.

8. A line assembly as recited in claim **1**, in which the barrier portion inhibits movement of particulate material larger than approximately 2 microns.

9. A line structure for use as a mud line assembly, where the line structure comprises:
   - a plurality of strands, where each of the strands comprises
     - a core portion comprising a plurality of core yarns, where each of the core yarns comprises a plurality of core fibers,
     - a jacket portion comprising a plurality of jacket yarns, where each of the jacket yarns comprises a plurality of jacket fibers, and
     - a barrier portion provided for each strand; wherein
   - the barrier portion is arranged between the core portion and the jacket portion of each strand to inhibit movement of contaminate material into the core portions of the strands.

10. A line assembly as recited in claim **9**, in which the barrier portion comprises filter material arranged around each core portion.

11. A line assembly as recited in claim **9**, in which the barrier portion comprises at least one strip of filter material arranged around each core portion.

12. A line assembly as recited in claim **9**, in which the barrier portion comprises at least one strip of filter tape arranged around each core portion.

13. A line assembly as recited in claim **12**, in which the filter tape defines at least one adhesive surface adapted to secure the filter tape to each core portion.

14. A line assembly as recited in claim **12**, in which the filter tape is wrapped around each core portion in a helical configuration.

15. A line assembly as recited in claim **12**, in which edges of the filter tape overlap.

16. A line assembly as recited in claim **9**, in which the barrier portion inhibits movement of particulate material larger than approximately 2 microns.

17. A line assembly adapted for underwater use in silt and mud at the boundary between earth and water, comprising:
    - a line structure comprising a plurality of strands, where each of the strands comprises
      - a core portion comprising a plurality of core yarns, where each of the core yarns comprises a plurality of core fibers,
      - a jacket portion comprising a plurality of jacket yarns, where each of the jacket yarns comprises a plurality of jacket fibers, and
      - a barrier portion provided for each strand, where the barrier portion comprises filter material; wherein
    - the filter material is arranged around the core portion of each strand to inhibit movement of contaminate material into the core portions of the strands.

18. A line assembly as recited in claim **17**, in which the filter material comprises at least one strip of filter tape defining at least one adhesive surface, where the filter tape is wrapped around the core portion in a helical configuration such that edges of the filter tape overlap.

19. A line assembly as recited in claim **17**, in which the filter material inhibits movement of particulate material larger than approximately 2 microns.

* * * * *